

Overview

The High-Energy X-ray Probe (HEX-P) is a \$500M mission in a low-inclination low-earth orbit using detectors that are similar to the WFI + HXT concept. The angular resolution would be 10-15" throughout 0.1-200 keV with effective area ranging from ~ 8000 cm² at 1 keV to ~ 100 cm² at ~ 150 keV. The FOV is 13' x 13' with Si and CdTe detectors. The technical design is based on NuSTAR heritage. Technical challenges include having an extendible 20 m mast, improving from the 50" NuSTAR resolution to < 15", and producing CdTe detectors with CalTech ASIC readout to improve the timing resolution to 0.1 msec.

What happens close to a Black Hole?

Concept	Measurement
Strong gravity predicts effects on X-ray spectra	<i>Fe-K line profile at CCD like resolution with continuum constraints from 0.1 to > 10 keV</i>

Concept	Measurement
Detection of the reflection Compton Hump	<i>Direct measurement of BH spectra above 30keV</i>

HEX-P has Si and CdTe detectors and therefore can measure black hole spectra at best with CCD resolution. However by combining soft and hard X-ray imaging HEX-P is replicating the WFI + HXT capability of IXO (but extended to higher energy). The Si detectors will be able to measure BH spin in bright AGN and the broad bandpass will help to constrain the continuum. In addition, reflection will be measured, achieving one of the original IXO measurement goals for black holes. NuSTAR will do some of this science when sources are observed simultaneously with XMM, Chandra or Suzaku. Astro-H may be better for sources bright enough (TBD what the limits are) for its calorimeter and hard X-ray imager. Coordinated HEX-P and ATHENA observations could in principle provide spin constraints for some sources comparable to those available from IXO. HEX-P will measure high-energy cut-offs for AGN, mostly for the first time given its sensitivity above 100 keV.

When and how did super massive Black Holes grow?

Concept	Measurement
Distribution of spins determines whether black holes grow primarily via accretion or mergers.	<i>CCD-resolution measurement of Fe-K lines but has strong constraint on BH continuum</i>
Concept	Measurement
Wide field survey of obscured AGN	<i>Detect obscured AGN in wide field surveys <1 sq deg</i>

This was primarily WFI science but HEX-P has a moderate FOV (13'x13') and somewhat worse PSF (~15"). Nevertheless extending the bandpass to > 10 keV but still at 15" resolution results in ~ 4000 AGN detected in a deep 1 sq. deg survey.

Having hard X-ray capability improves constraints on spin from current CCD-only measurements, although the RFI response does not quantify how many sources this would be possible for (only showed MCG-6, which is one the brightest AGN with strong and broad Fe-K emission).

How does large scale structure evolve?

Concept	Measurement
get more accurate cluster masses by taking non-thermal pressure into account	<i>does not specify specifics of measurement, (flux limits, number of clusters)</i>

The authors argue that measuring magnetic pressure / CR populations is critical through detection of non-thermal hard X-ray emission, but do not quantify how this compares to calorimeter velocity measurements which was the primary IXO measurement. The RFI response does not say how many clusters this will be possible for. HEX-P cannot do WHIM science at all since it lacks high-resolution spectroscopic capability.

What is the connection between supermassive black hole formation and evolution of large scale structure (i.e., cosmic feedback)?

Concept	Measurement
Resolve cluster bubbles and cavities and AGN jets where energy from AGN is deposited	<i>Detection of cluster cavities may be possible in some cases but only with <15" resolution</i>

HEX-P would offer no great improvement over existing missions and does not address IXO measurements here. The authors could have argued that cavities may be detected, although 15" resolution may be inadequate for this purpose. Potentially HEX-P could look for AGN in clusters that are obscured but nevertheless depositing energy.

How does matter behave at very high density?

Concept	Measurement
Neutron star Equation of State can be mapped by measuring M,R for a range of NS	<i>Can do timing but timing requirement is 10X worse than IXO</i>

Concept	Measurement
Determine broad-band properties of XRBs	<i>Spectroscopy at < 150 eV resolution 0.3-10 keV, < 1 keV resolution 10-200 keV</i>

HEX-P can do timing at the 0.1 msec level, 10X worse than the IXO requirement, and can look for QPOs, etc. above 10 keV. It can measure spectra of BHs and NSs above 10 keV, particularly near expected cut-off in IC scattering plasma and for XRBs other nearby galaxies.